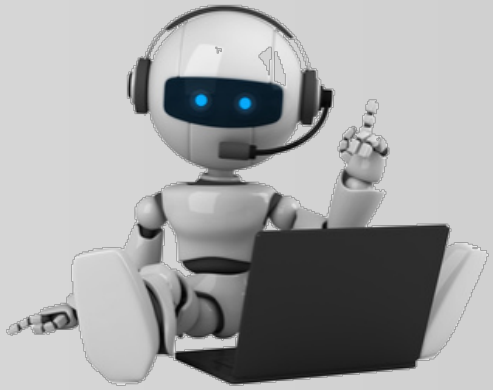
Instructional design and natural language processing in **dialogue-based CALL**



Serge **Bibauw**

Thomas **François**

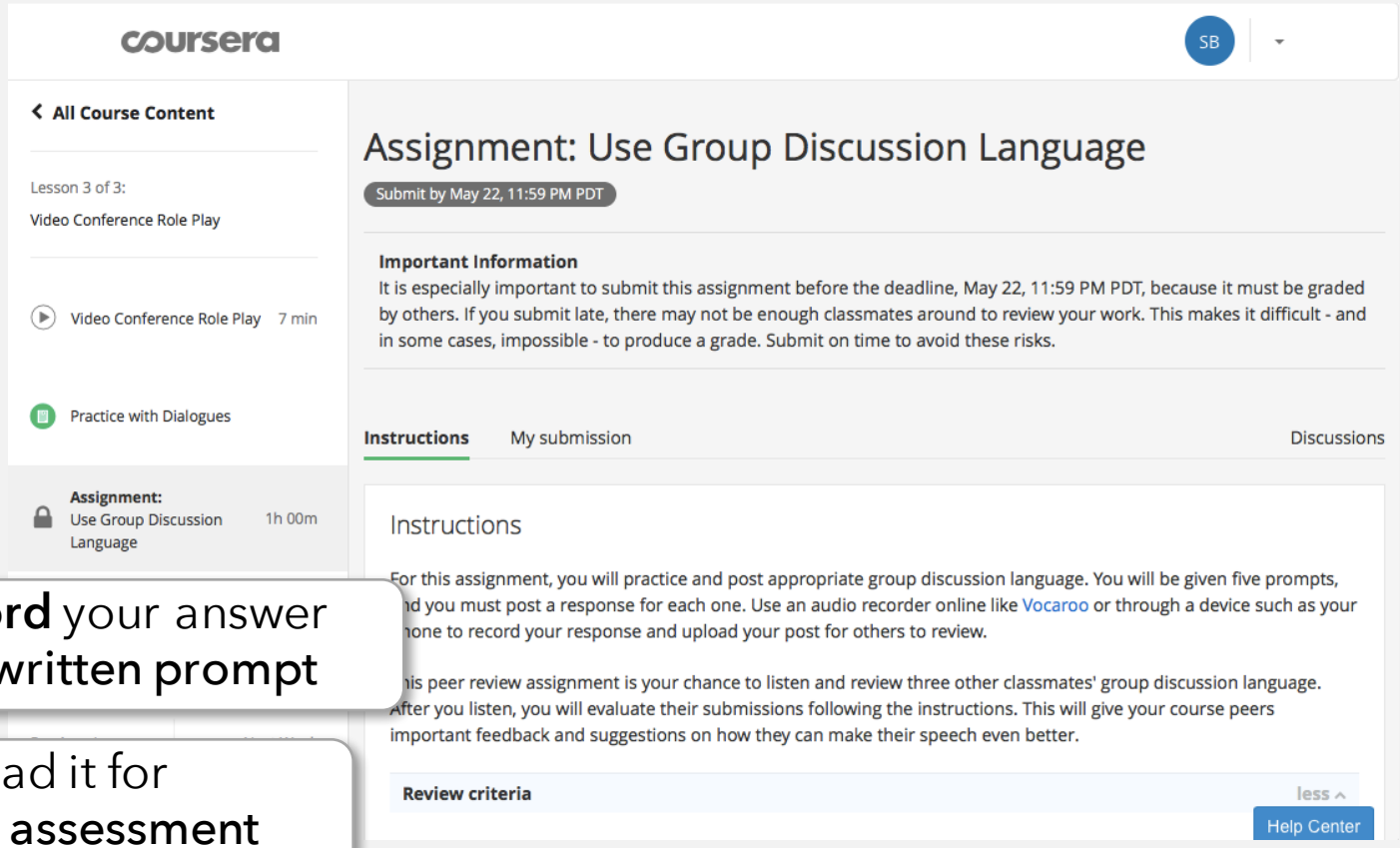
Piet **Desmet**

CALICO Conference
May 11, 2016

KU LEUVEN iMinds UCL Université catholique de Louvain

How do we practice **speaking** in a MOOC ?

How do we practice **speaking** in a MOOC ?



Record your answer to a **written prompt**

Upload it for **peer assessment**

In many learning environments, learners lack **speaking in interaction**

Online learning environments

MOOCs, apps & websites for autonomous language learning

Synchronous computer-mediated communication (**SCMC**) – whether **audio**, **video** or **text chat** – is difficult to **supervise** and does not **scale** well.

Foreign language instruction contexts

No L2 outside the classroom
Large classes in developing countries

Limited **teacher-student** interaction

Very rare **peer** interaction

No opportunities **outside** the class

Lack opportunities for **spontaneous interactive** practice of the L2

Dialogue-based CALL

Dialogue-based CALL refers to any application or system allowing

to maintain a dialogue
[immediate, synchronous interaction]
[written or spoken]

with an automated agent
[tutorial CALL (≠ CMC)]

for language learning purposes.

Designing dialogue-based CALL systems
to allow for interactive and meaningful practice

Instructional design → Technological approach

- Learning outcomes
- Task to accomplish
- Learning principle
- Degree of interactivity
- Scaffolding

- Dialogue modelling
- Initiative management
- Natural language understanding
- Adaptivity and user modelling

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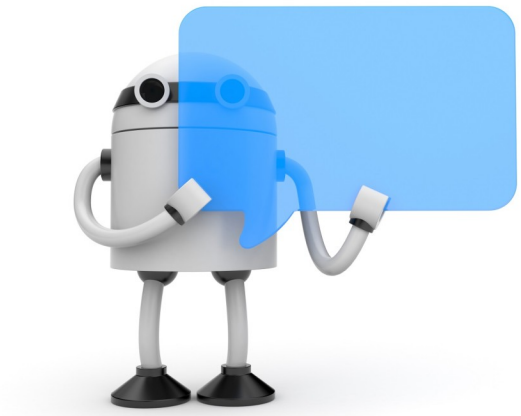

Previous research & existing systems

A research synthesis from 1982 to 2015

Instructional design & technological challenges

A typology of dialogue-based CALL systems

Natural language processing approaches to dialogue systems

From handcrafted rules to machine learning

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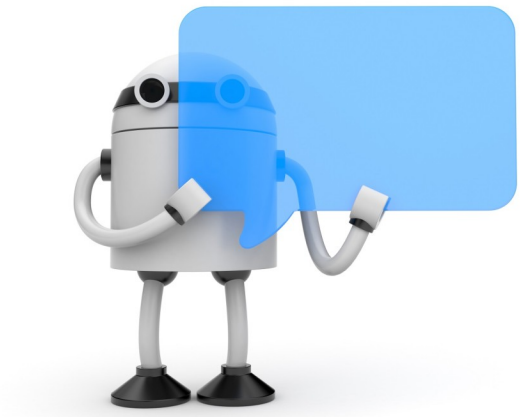

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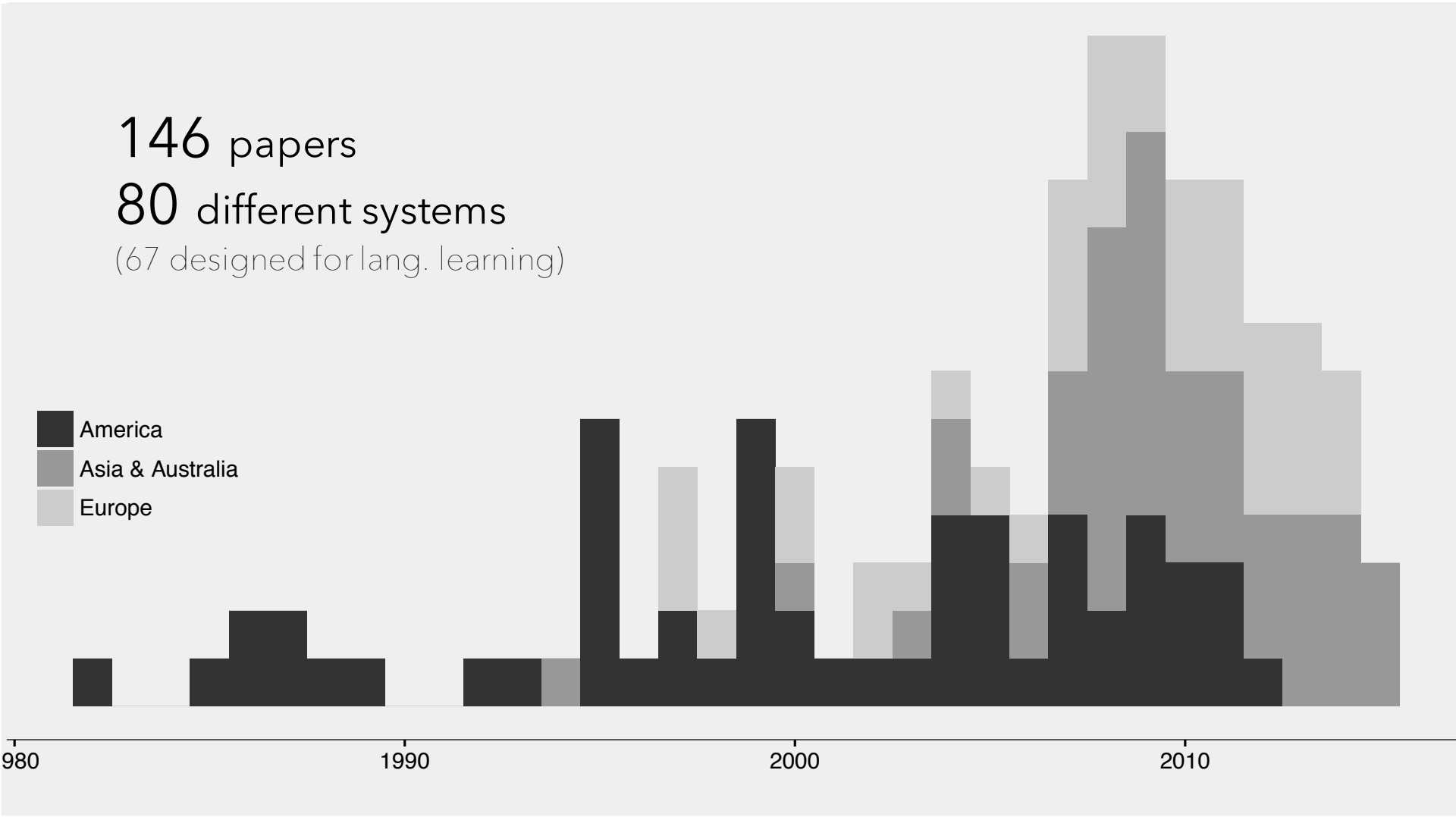
Corpus of studies

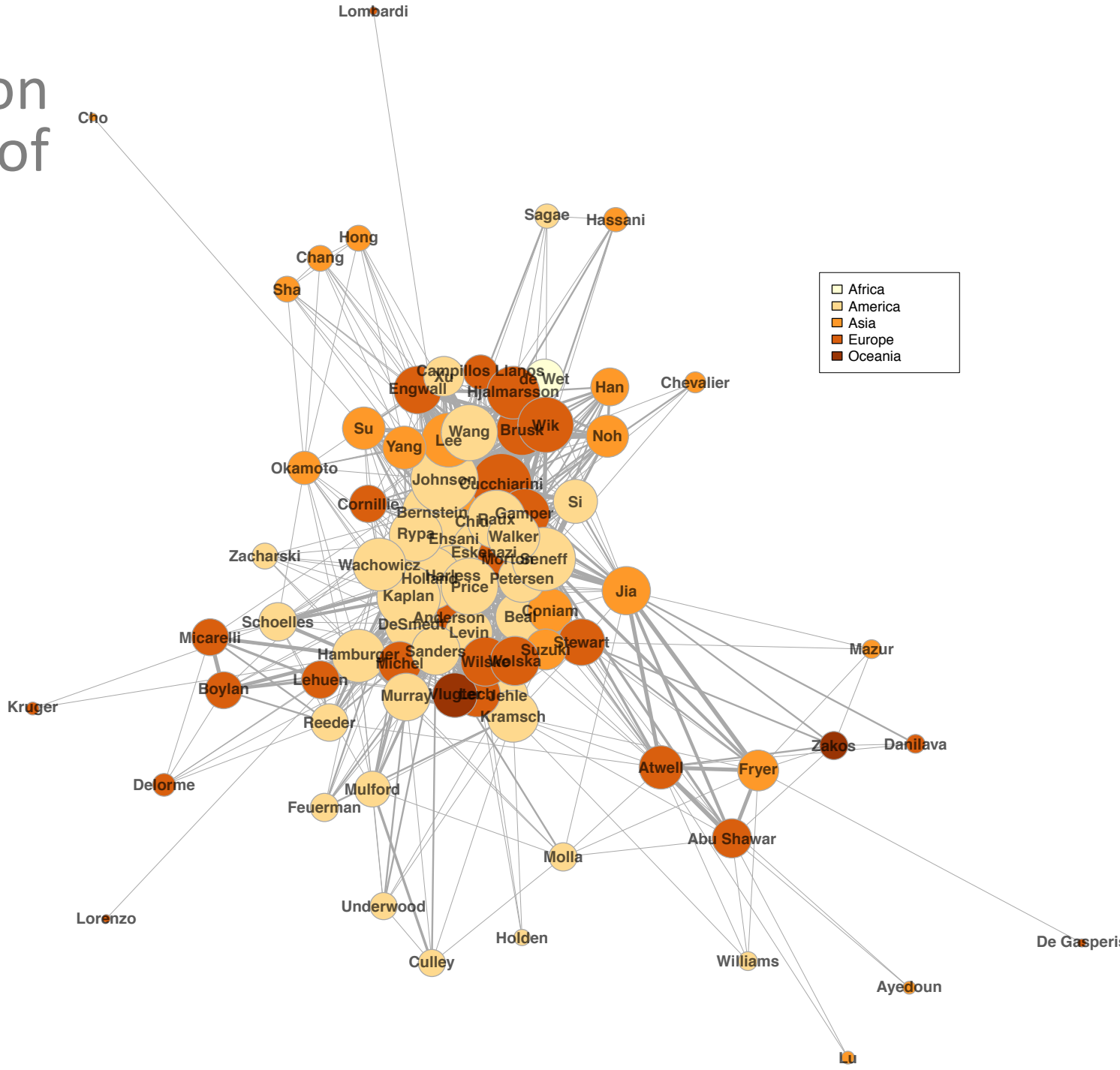
146 papers

80 different systems

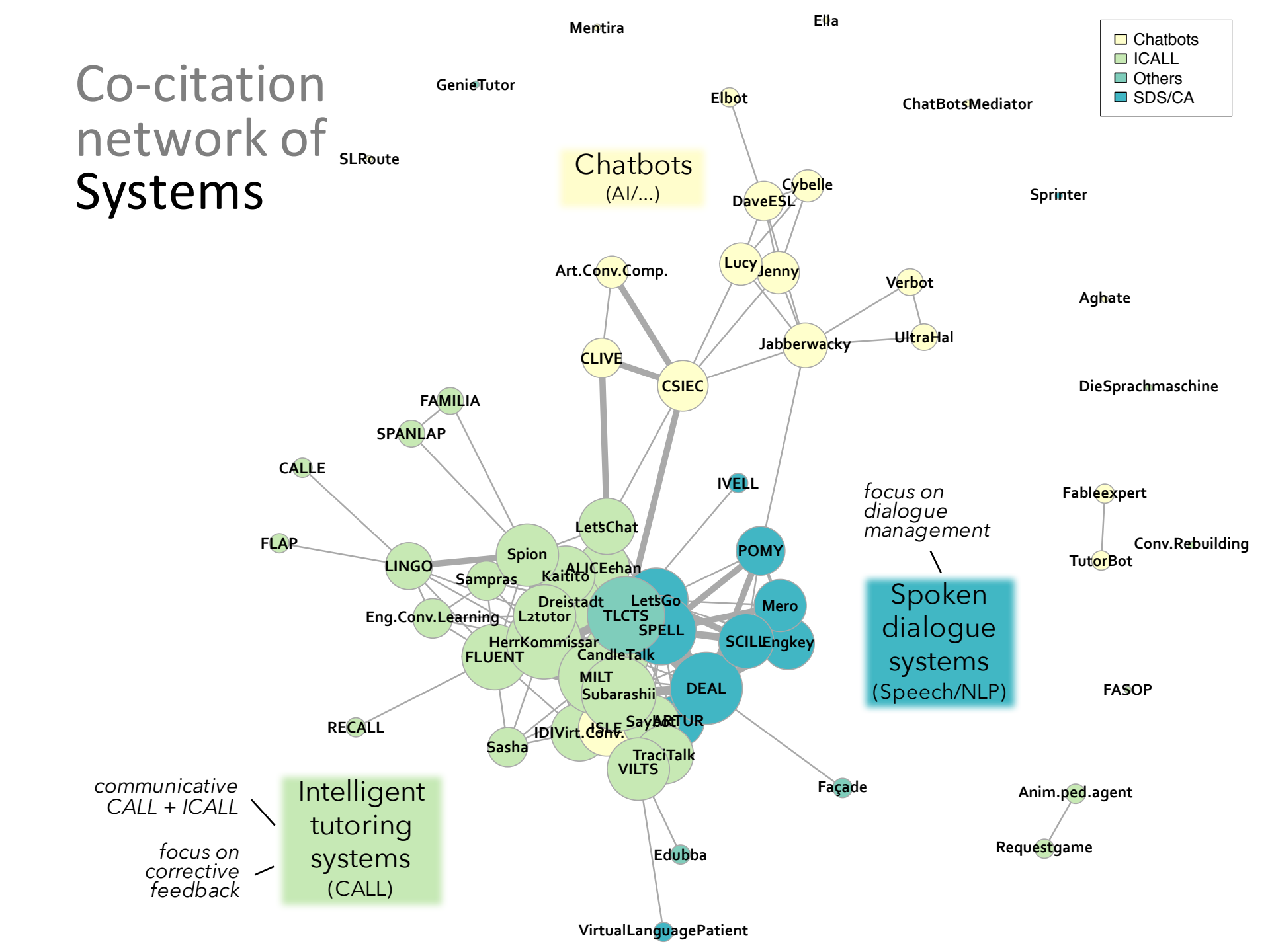
(67 designed for lang. learning)



Co-citation network of Authors

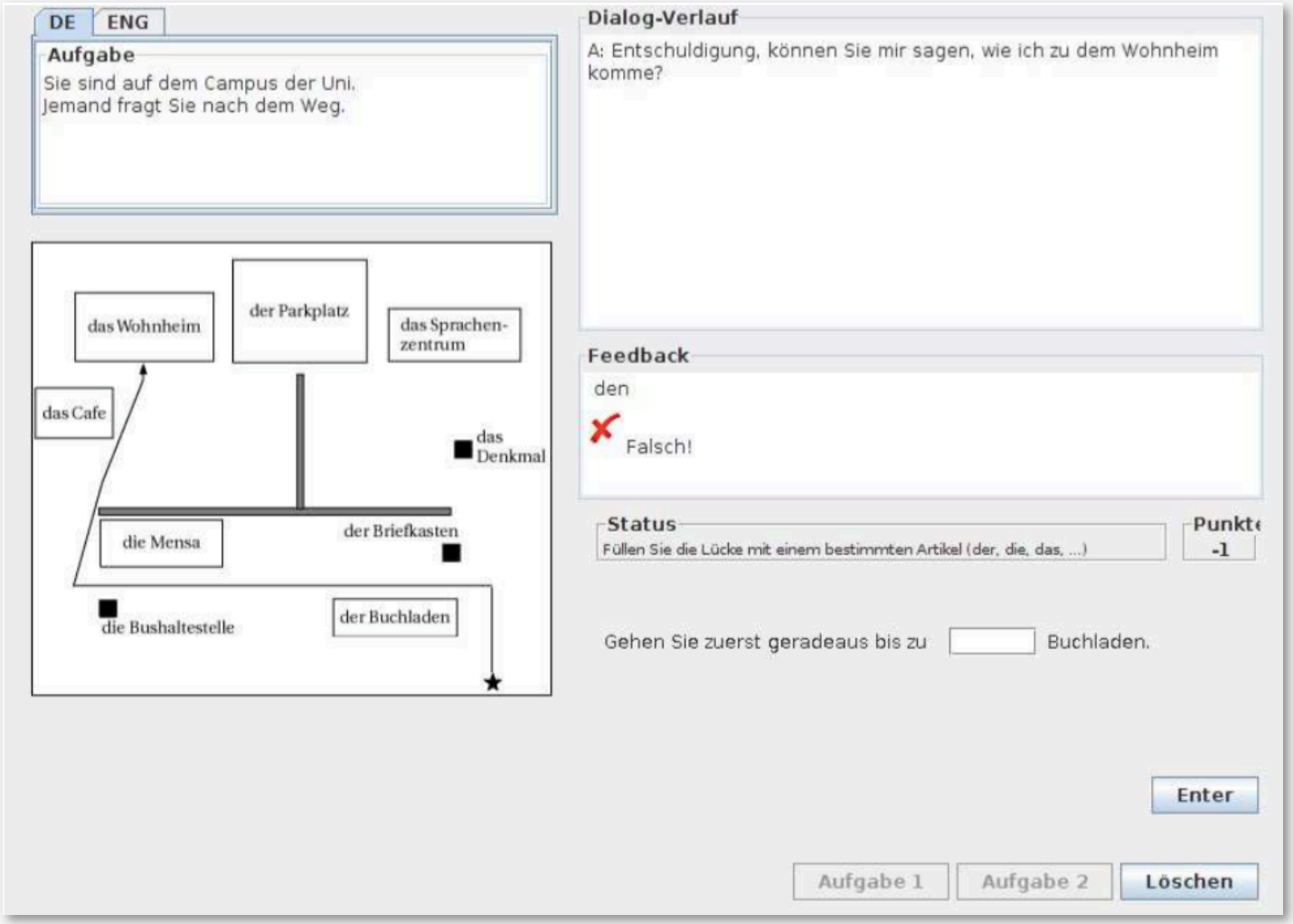


Co-citation network of Systems



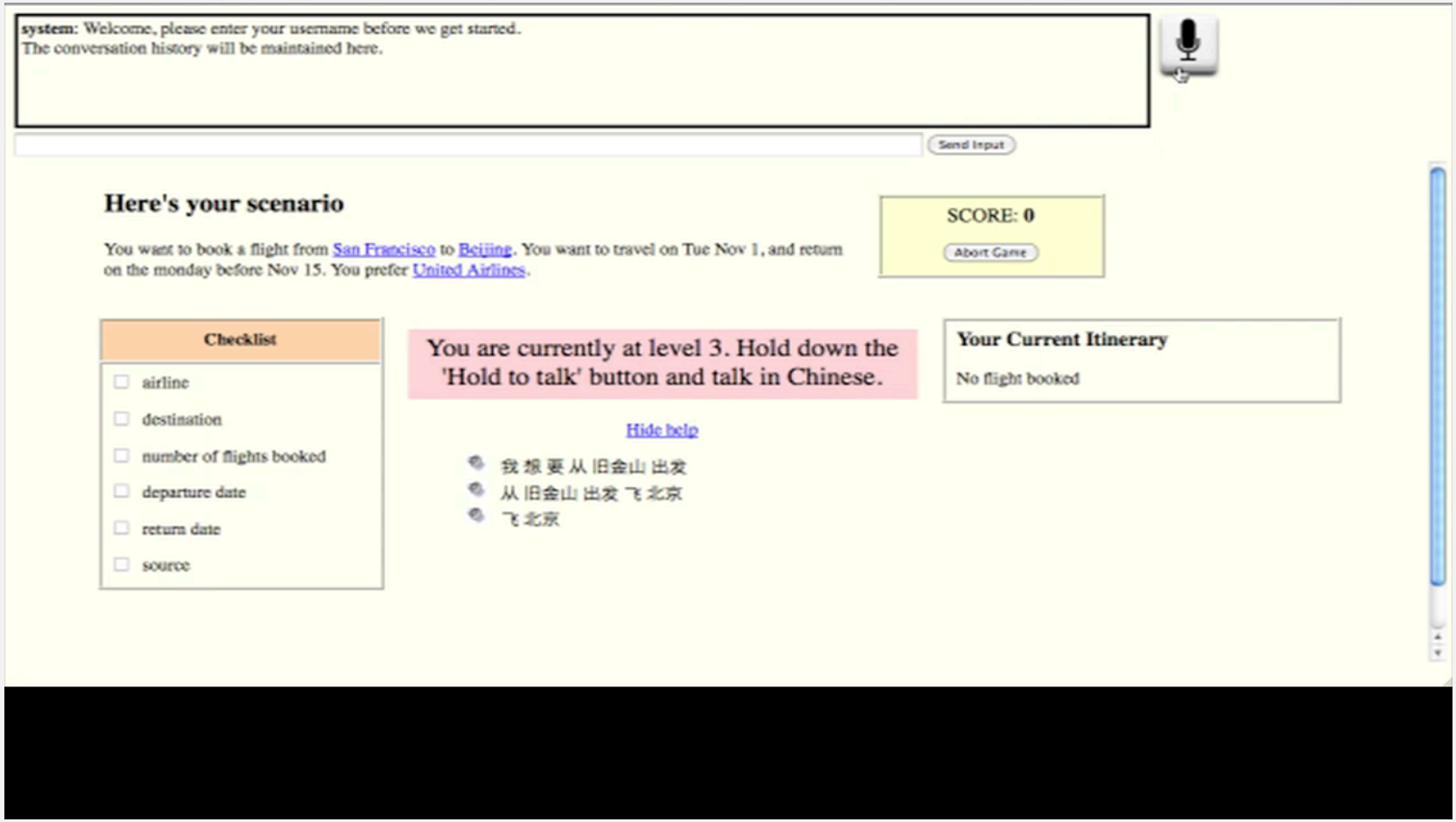
Intelligent tutoring system

Map task (Wilske, 2014)

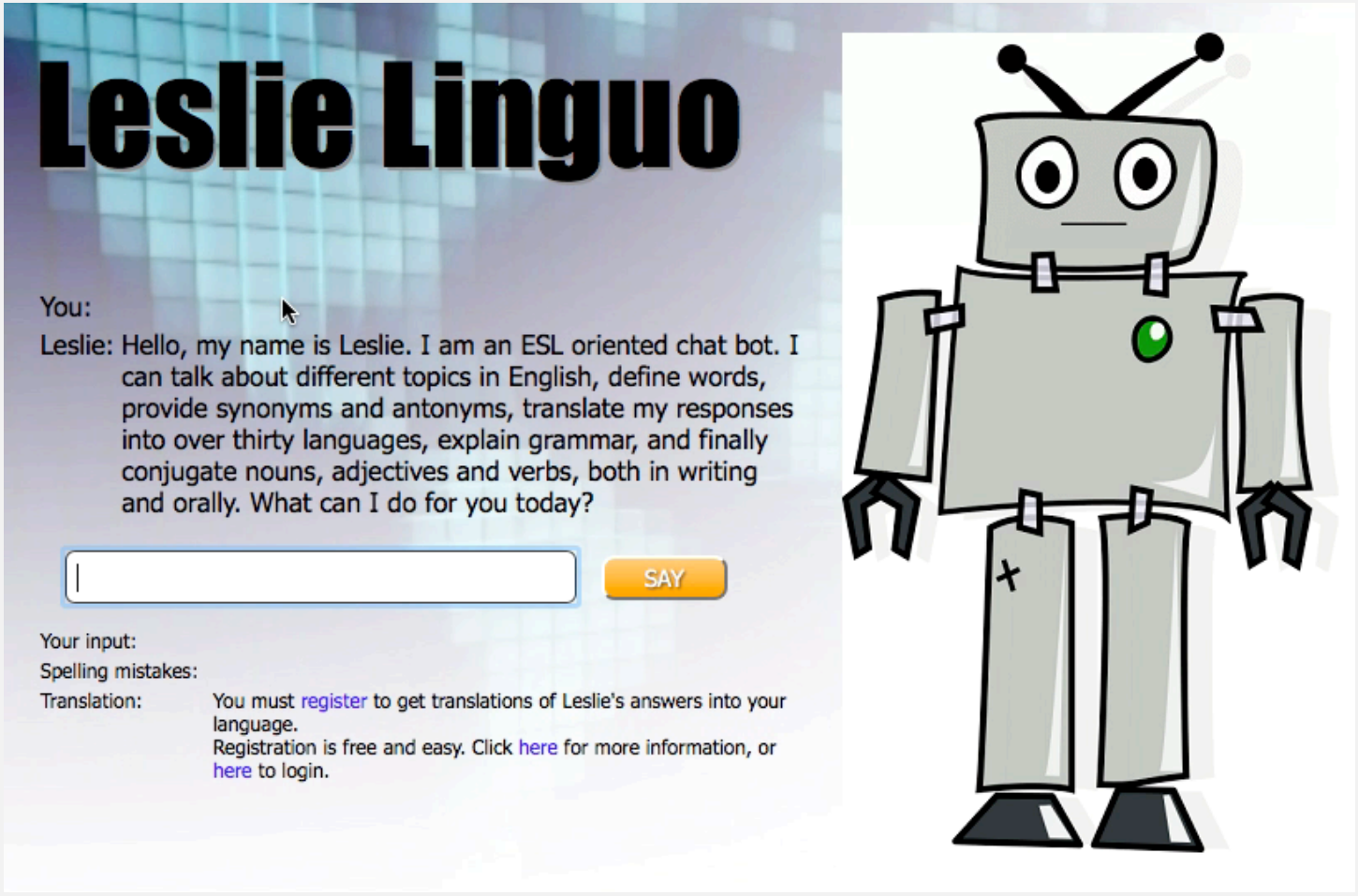


Spoken dialogue system

SCILL (Seneff *et al*, 2007)



Chatbot
Leslie Linguo



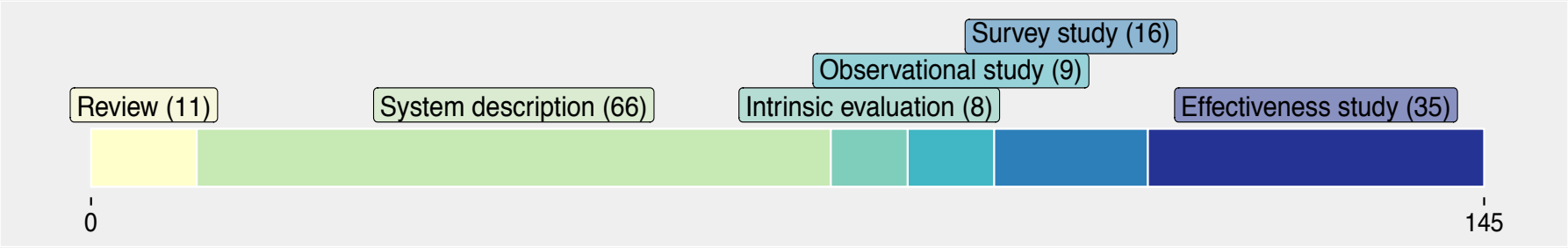
Dialogue simulations in a virtual world

Tactical Language and Culture Training System (Johnson *et al*, 2005)

Limitations

Almost none of the 80 systems studied have made it to the **general public**.

We know very little about their **effectiveness on language learning**.



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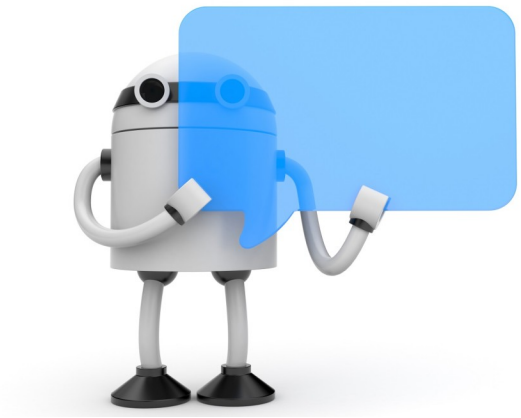

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Need for an instructional design approach of dialogue-based CALL

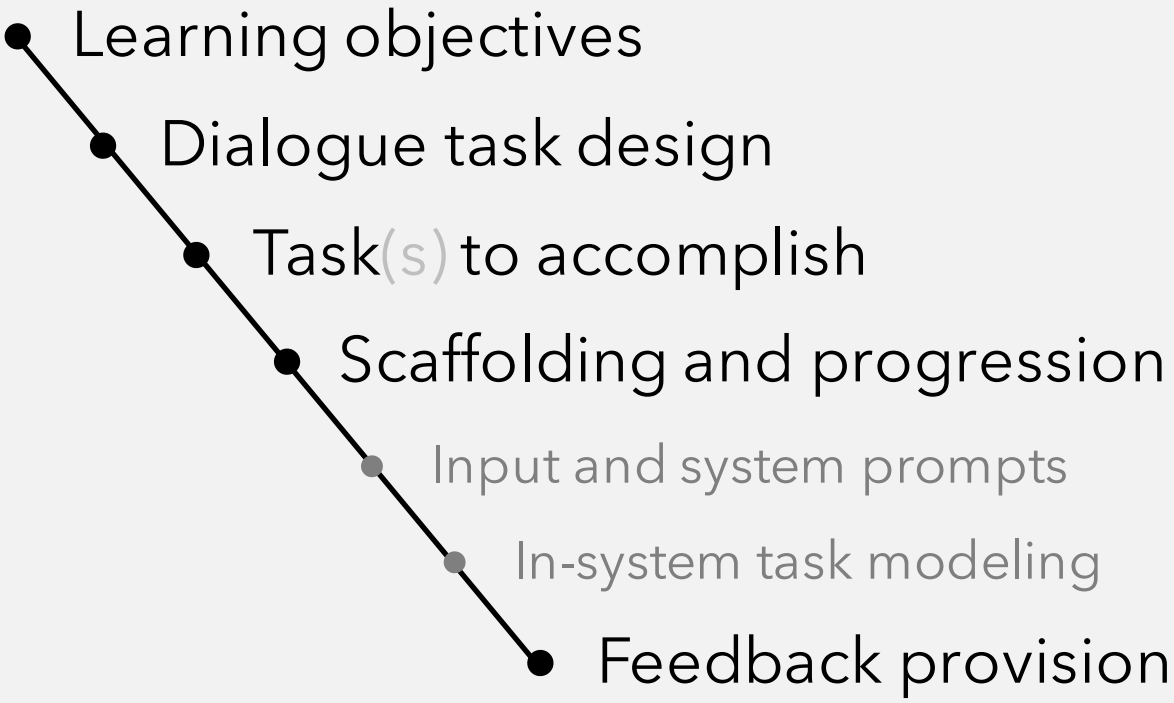
Available technology is not enough

> "Free conversation" with an all-purpose "question answering" chatbot: ineffective, aimless, vapid.

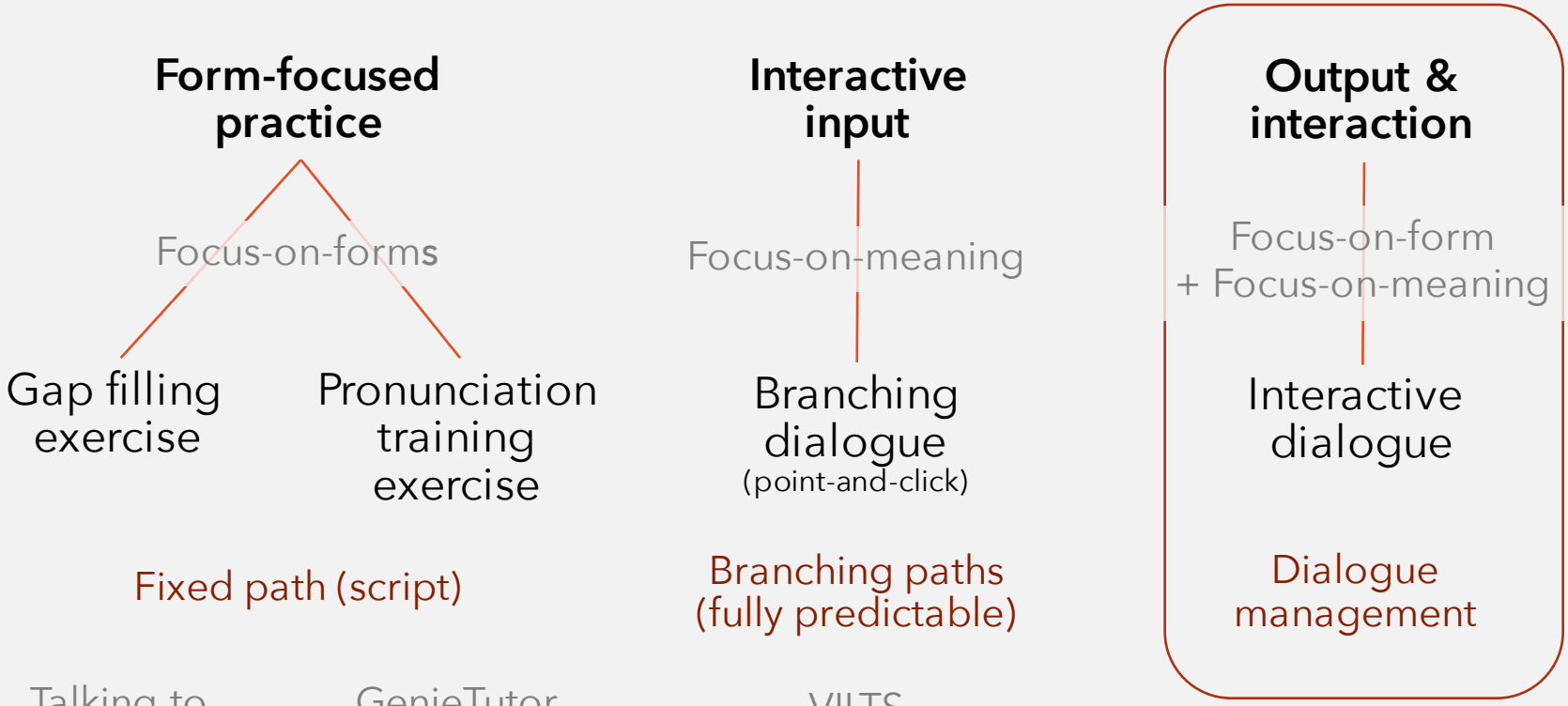
Various learning goals ⇔ various technologies

Bottom-up typology of dialogue-based CALL

Instructional design framework
for dialogue-based CALL



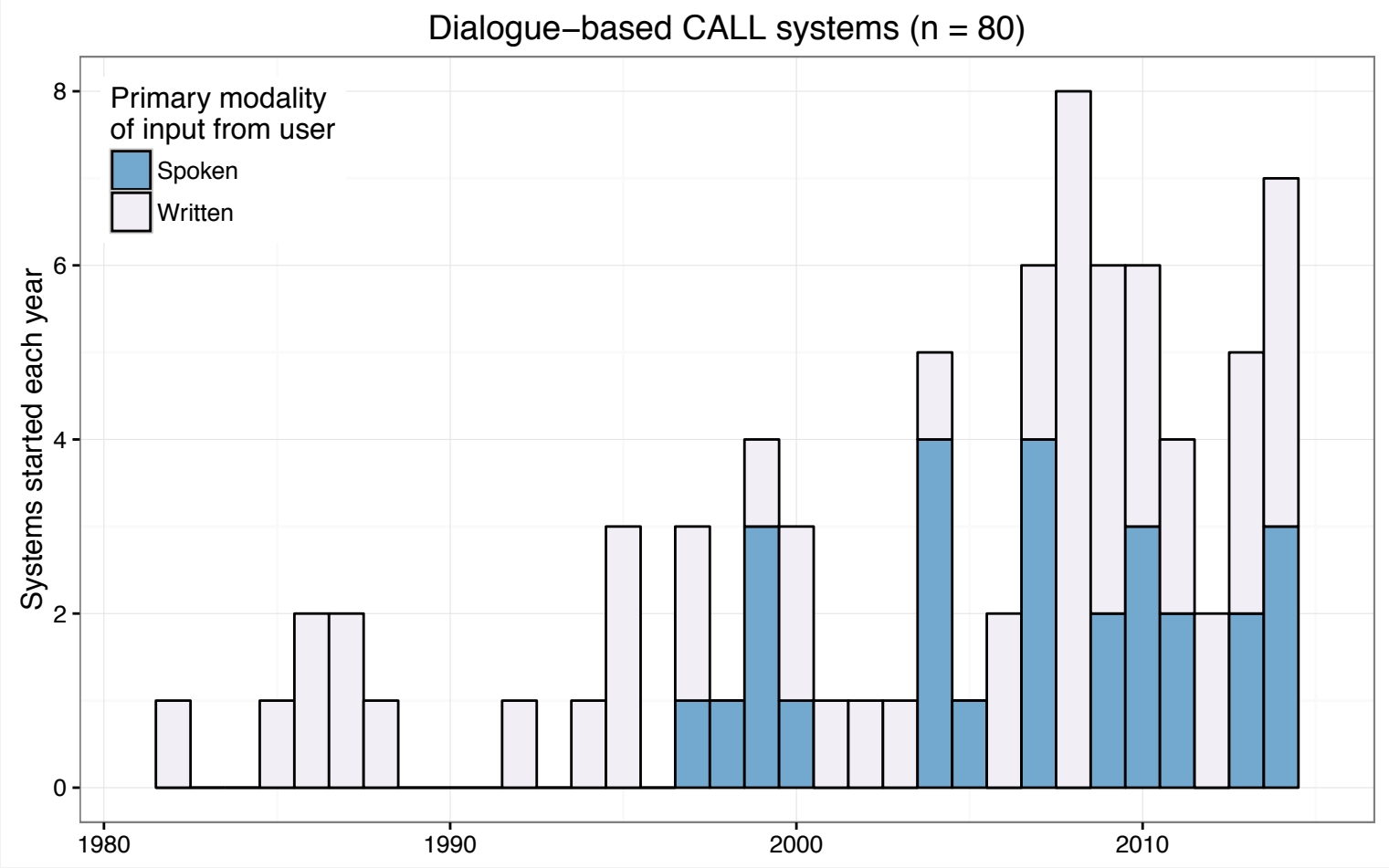
Learning principles



Dialogue task design
for interactive dialogue management

	User-initiated open-ended practice	**Pre-scripted interaction**	**Interaction in fixed task**	**Interaction in multiple task**
Goal-orientation	Open-ended	Goal	Goal	Goal
Initiative	User	System	Mixed	Mixed
Interactivity	High	Low	Medium	High
	↓	↓	↓	↓
Dialogue control	Pattern matching	Graph	Frame	Probabilistic control
Information extracted	Keywords	–	Entities	Intent + Entities
	Chatbots CSIEC (Jia, 2009)	Subarashii (Ehsani et al, 1997) Kaitito (Vlugter et al, 2009)	Let's Go (Raux et al, 2003) SPELL (Morton et al, 2011)	POMY (Lee et al, 2014)

A short detour by
Modalities (spoken vs. written)



Spoken or written
Beyond the modality dichotomy

Not so much of an issue today.

Speech recognition (ASR) and
speech synthesis (TTS) **as services** (SaaS)
can be implemented into any system
to enable speech capabilities

Spontaneous output vs. **prepared** output
(synchronous, interactive) ›‹ (asynchronous, monologic)
as a more relevant distinction, with
major consequences on L2 acquisition

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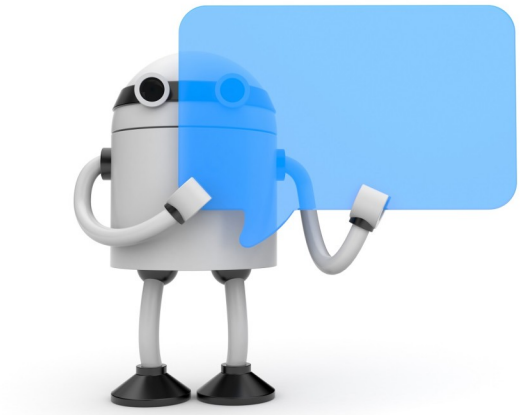

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Dominant dialogue management paradigms and frameworks

Paradigm	**Chatbot**	**Frame-based** dialogue system	**Deep learning**	**Probabilistic rules**
Principle	Handcrafted rules	Handcrafted rules	Machine learning	Handcrafted rules + machine learn.
Dialogue control on	Normalized utterance	Slot-value pairs	Internal neural network representation	Intent & entities recognition
Frameworks	**ChatScript** **AIML** (see Pandorabots) Rivescript	**VoiceXML** CSLU Toolkit CMU Olympus	–	**OpenDial** **Wit.ai BotEngine** Api.ai Recast.ai IBM Watson Microsoft LUIS
			Note: requires extremely large corpus	
	1990s-2000s	1980s-2000s	2013-...	2014-...

Why probabilistic approaches
to dialogue management?

Chatbots

- Some systems with 250 000 rules!
- And still dramatically limited, using massive avoidance strategies.

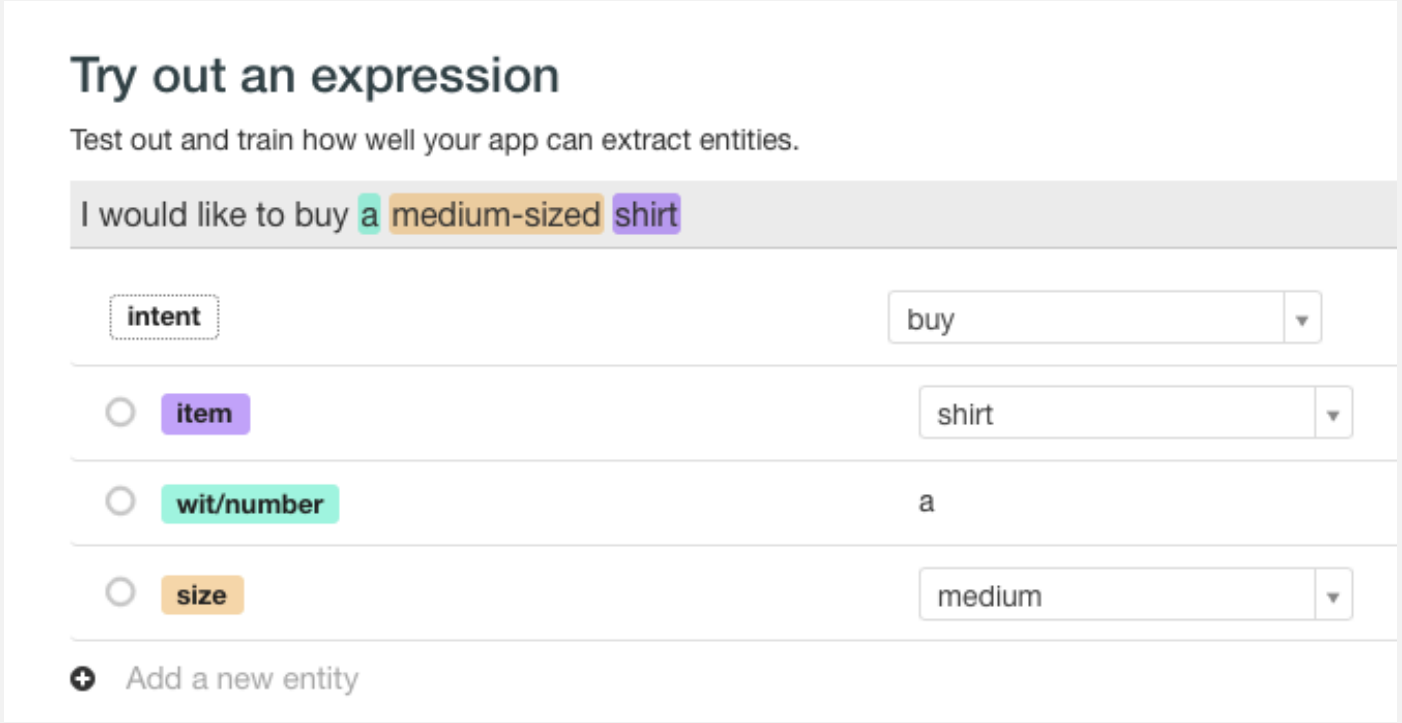
Deterministic rules cannot describe all cases.

- Ambiguity pervades language.

Deep learning techniques have obtained good results, but require huge corpora
(Mesnil et al, 2013; Vinyals & Le, 2015; Shang et al, 2015)

Probabilistic rules offer the best of both worlds: statistical, data-driven techniques possible with small corpora

Intent and entities recognition
with Wit.ai Bot Engine



Dialogue-based CALL
Summarizing

Need for **spontaneous interaction**

Previous research & systems
Scattered field, between ICALL,
spoken dialogue systems and chatbots

Instructional design framework
Towards goal-oriented,
mixed initiative interactions

NLP approaches to dialogue
From handcrafted rules to probabilistic rules
for intent recognition and dialogue control

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